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Big Data Problems: Understanding Hadoop Framework

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ABSTRACT: ***THE IT INDUSTRY HAS SEEN REVOLUTION FROM MIGRATING FROM STANDARDIZATION TO INTEGRATION TO VIRTUALIZATION TO AUTOMATION TO THE CLOUD. NOW THE INDUSTRY IS ALL SET TO SPIN AROUND THE COMMERCIALIZATION THAT IS DATA ANALYTICS- BUSINESS INTELLIGENCE. FROM ALL FIELDS DATA IS GENERATING BE IT ANY INDUSTRY SECTOR. THUS VOLUME, VARIETY AND VELOCITY OF THE DATA HAVE BEEN EXTREMELY HIGH. THUS TO HANDLE SUCH ENORMOUS DATA WHERE TRADITIONAL DATABASES IS NOT POSSIBLE THE PROBLEM OF STORAGE, COMPUTION,LOW NETWORK BANDWIDTH AND LESS FAULT TOLERANT WHICH LEAD TO THE INTRODUCTION OF BIGDATA.IN THIS PAPER WE HAVE FOCUSED ON THE BACKEND ARCHITECTURE AND WORKING OF THE PARTS OF THE HADOOP FRAMEWORK WHICH ARE THEMAP REDUCE FOR THE COMPUTATIONAL AND ANALYTICS SECTION AND THE HADOOP DISTRIBUTED FILE SYSTEM (HDFS) FOR THE STORAGE SECTION.***

Keywords:
Hadoop,HDFS,MapReduce,Jobtracker,Tasktracker,Namenode,Datanode.

I. Introduction

With the industrial revolution of data, tremendous amount of data is generated .with the emergence of companies the data which was confined to few gigabytes has now gone past peta into zetta bytes.Technology is so much in use that we are in an era that we are able to figure out about human behaviour through the analysis and prediction of the data generated.Data is generated through machine sensors,GPS,billing,transactions. Emergence of new data sources has gone so high that the storage capabilities have fell short. The traditional datawarehouses are limited to RDBMS concept which could handle more of the structured data but when in this era when we the data is generating in all directions flexible unstructured data storages NoSQL databases are the new crush of the industry. The amount of unstructured data generated can we figured out by the fact that every month 1 lakh new users are registered on facebook.5 billion mobile phones are in user in 2010, 30 billion new pieces of content is created or shared on Facebook. “Bigdata” refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyse. Now theindustry is in making sense of these generated figures by analysis and prediction of different parameters. Datawarehouses are also an important part when it comes to

analytics."Bigdata" can we implemented on both structure or unstructured data that is on both analytical DBMS and NoSQL databases.Bigdataisproved as an asset when it comes to analyse the data in motion or stream processing. Most of the larger firms are generating huge amounts of data. With the coming of cloud models that incorporate sound data storage companies are processing enormous data. This huge generated data is not only a hardwaredata storage problem but also on file system design, designing implementation,IO Processing and scalability issue. To fulfil the needs of the data generated data storage has significantly improved. But HDD data access has not improved that much.Thus the main problems with this emergence of data are particularly where to store this enormous data or the storage capacity problem. The second one is to make business sense out of it for analytics which is a part of computation problem. Other important factors include the network bandwidth and the reliability. Reliability refers to the response if any unfavourable condition materializes which can lead to the loss of important data and in turn leads to the analysis flaw of the system. Thus a backup of the data stored should always be present to cope up with the risk situations of data loss. One other major concept is the concept of network bandwidth.

Thus storage, computation,reliability,bandwidth issues are some of the bigdata problems which the modern IT industry is facing. And yes Hadoop framework can be a best framework which can provide with these features and other additional features which could turn out to be an asset for the industry. In this paper we would be discussing in detail the methodology by which the Hadoop frame work can help us achieve the above discussed challenges.

ARCHITECTURE AND FUNCTIONING

MapReduce: The analysis part of the Hadoop framework is managed by the mrv1 framework. It is a programming model developed by google. It works on the principle of divide,sort,merge,join.It was built with the aim of batch processing and parallel processing.It is natural for the ad-hoc query,web search indexing, Log processing. From business aspect,the main objective of MapReduce is deep data analytics based on which the prediction is done observing the patterns. It comprises of two functions, to analyse the large unstructured datasets,the "Mappers" and the "Reducers". Both of the “Mappers” and the “Reducers” are user defined functions.The model is based on parallel programming and the datasets are parallely processed on the different nodes of the cluster.Map and Reduce functions are available in languages such as LISP. Apart from themap and reduce function also comprises the partitioner and the combiner functions. Users of MapReduce are allowed to specify the number of reducer tasks they desire according to which the data gets partitioned among these tasks through the partitioning function. There is also a combiner function; the combiner function is executed on every node that performs map function.it merges the local disk data before moving it to the network.The mechanism for MapReduce is as mainly

divide and conquer, the main program is initiated and an dataset is taken as input and the according to the job configuration the master program initiates the various notes for map and reduce purposes, after that the input reader is being initialized to stream the data from the datasets the input reader breaks file into many smaller blocks and maps the data blocks to the nodes which are assigned mapper nodes. As told above the map and reduce functions are user defined, thus in the mapper nodes the user map function is executed and based on it {key ,value} pairs are generated , the results generated by the mappers is not simply written to the disk,some sorting is done for the efficiency reasons. Map tasks have circular memory buffer in which it stores the output,by default its capacity is 100 MB,it can change dynamically to the size,when the threshold size reaches 80%, a background thread will start to spill the contents of thread.Map blocks until the spill is complete.Before writing to the disk respective sorting is done on the pairs generated now the already initiated "Reducer" nodes comes into action. All the sorted data are sent to the reducer nodes by the partionerfunction here it collects the same keyvalue items andthe user given reduce function and aggregates result as a collective entity.Partion and combiner function is applied on the output of the sort result so that there is less data to be written onto the disk.The produced result is collected by output reader and thus the parallel processing terminates. Architecture of MapReduce consists ofJobtrackerand multiple trackers. Job tracker acts as the master and the task trackers act as the slaves.Jobtrackersits onto the Namenode and the tasktracker sits on the correspondingDatanodes.when the task is being submitted to theNamenode and the job tracker is being informed about the input, via heartbeat protocol it checks for the free slots in the task tracker and assigns maptask to the free tasktrackers.Maptasks track data from the splits using record reader and input format and invoke map function andaccordingly a key value pair is generated in the memory buffer. Once all the tasktrackers are done with the maptask the memory buffer is flushed to the local disk within mapnode with an index and the keyvalue pair the map nodes report to the Jobtracker and the Jobtracker starts notifying the reduce task nodes of the cluster for the next step which is the reduce task. The concerned reduce nodes download the files (index and keyvalue pair) from the respective mapnode. Now the reduce nodes reads the downloaded file involve the userdefined reduce function and that provides with the aggregate key value pair. Each reduce tasks are single threaded. The output of each reducer task is written to HDFS temporary file. When all reducetasks are finished the temporary file is automatically renamed to final file name.

HDFS: in traditional blocks of disks the maximum data that can be stored or read was 512bytes,later the file systems blocks came which could accommodate few kilobytes,with the current volume of data it is next to impossible to store or analyse this teravytes or zettabytes data over a distributed network using traditional system. Hadoop distributed file system is a Hadoop data storage framework implemented on the commodity hardware. HDFS blocks can accommodate a few 68-128 MB.Block extraction is simple in HDFS like replication of blocks is at block level rather than file level.HDFS is created keeping MapReduce in mind.HDFS represents a distributed file system that is designed to store enormously large datasets and at the same time high throughput to access datasets.HDFS contains many racks which are mounted by thousands of servers and with each server thousands of nodes are attached so the probability of the failure of the hardware is at its peak.So the Hadoop design should be resistant to the fault tolerance, have high throughput for data streaming.

Characteristics or goals of HDFS:

1. High fault tolerance.
2. Moving computation is better than moving data.
3. able to handle large datasets.
4. Cross platform compatibility.
5. High throughput for streaming data.

Architecture:HDFS run on GNU/Linux operating system and is built in java. HDFS works on the principle of master/slave architecture. It consists of a Namenode which is unique for the whole cluster; there is a secondary Namenode which acts as a checkpoint. Rest all the nodes of cluster are said to be the Datanodes these act as the slaves. Namenode acts as the master instructing the Datanodes to perform operations. When a large dataset is set to be entering into stored in HDFS the large file is split into numerous blocks, these blocks can reside of the same file are stored on different nodes of the cluster,each block stored is stored as a file on the local file system.HDFS maintains a single namespace for the distributed file system,this namespace is maintained in the Namenode,since the blocks are distributed over the cluster and the Datanode store in the local file system, this file system tree and the metadata and directories in the trees is also maintained in the Namenode. This information is dynamic in nature.Name node consists of 2 files for storing all these data which are FsImage and the edit log respectively.FSimage stores data block file mapping and filesystem properties whereas the edit log consist ofall the changes done to the file system,all the modifications to blocks are subjected to the editlog. For the proper working of HDFS the most important thing is the master the Namenode if the Namenode fails the HDFS becomes obsolete,it should be throughout functional,if it fails there could be huge dataloss since HDFS is used by massive datasets. Though we cannot fully control the Namenode failure but we can minimize its effect by having checkpoints. We have secondary name node for it which merges the fsi image and the edit log periodically, when the metadata from the Namenode is stored on the local disk it is also mounted on to N mountpoints just as a backup. These CPU intensive merge activities are on the separate system. If at any moment the Namenode fails then the fsi image from the mounted sites is picked up and it runs as the primary Namenode.this is how secondary Namenodes can be vitial.The working of HDFS is kept very simple and dynamic, when the system starts the system is in a neutral state waiting for the data nodes to send information about the vacant blocks so that the name node can assign the block to Datanode, via heartbeat protocol and block reports the name not get these messages based on which the Namenode allots the different data chunks to the different data nodes. IfNamenodefails secondary node acts as the Namenode as discussed earlier. After this the Namenode works on the block replication if any less replication is done thanthe replication factor it works for it until it fulfils. As the Namenode boots the FsImage and the editlog are accessed

from the local disk and all the editlog transactions are mapped into existingFsImage thus creating newFsImage file, meanwhile the old editlog is flushed, that's how it is dynamic.

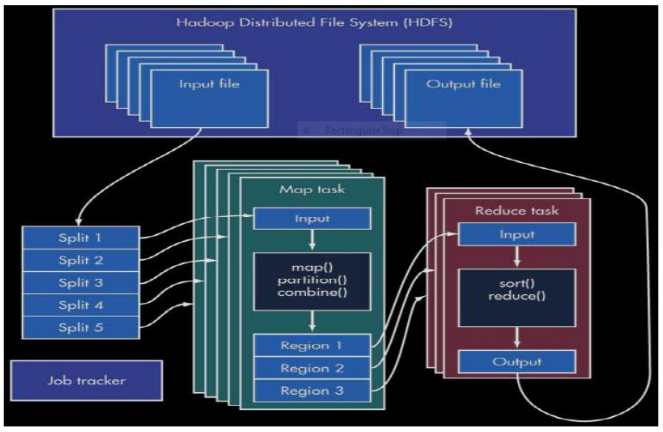
Reliability: An exceptional quality which the Hadoop framework persist is that when the input file is to store in HDFS frame work it goes through the splitting of the large dataset in to smaller chunks. The blocks of data are replicated over different nodes of the cluster. Replication is done on the data node level. Replication factor is introduced which is the number of replicas available of the same block. This provides fault tolerance, for eg. If a rack fails then all the corresponding nodes to that fail so by replication we have the same data block over other blocks thus we can access the required data block increasing reliability. Replication over the same node is avoided because replication or backup over the same node is of no use since a node fail its back up is also gone thus Hadoop uses replication around different nodes of the cluster. Also the secondary Namenode which is the back of the primary Namenode as discussed earlier carries the backup of the FsImage and editlog to act as primary name node if the main Namenode fails. This ensures the reliability of the Hadoop framework.

High performance: Another concern in the distributed network is the Network Bandwidth. Yes ,Hadoop is the solution to Bandwidth constrain too.Since the Hadoop uses more of the local data .This can be understood by this example that while replication if the Hadoop has a replication factor 3 (most prominent case) then it means it will save three of its replication copies on the nodes. If it strore's each replicated copy on the different node of the different rack that would enhance the data reliability and availability but what about average network bandwidth which is used when we fetch the block for read purpose? (since while read or write operation each part is to be fetched from different racks)For this reason another strategy is used,2/3 of the replicas are on the same rack and the rest 1/3 is done on the different node of different racks this improves performance, availability and fasterns the access time .thus it minimizes bandwidth consumption.

Diagrams/result

Hadoop framework which consists of two main frameworks which are the MapReduce framework and The HadoopDistributed File System are interlinked .Mapreduce is mainly for the compute or analysis part which is the heart of the BigData Analysis.where as the HDFS is mainly for the storing part.Both of these intra Frameworks are Hightly depended n each other.MasterSlave architecture exists in the Hadoop. The input file is didvided into multiple blocks and is saved on different nodes(data nodes),the replication of these blocks(to increase the reliablity in case of any accident) is also on on the same or differen racks keeping minization of network bandwidth usage in mind. The jobtracker sits over the namenode input file is being sent to the namenode which divides and the file blocks are saved on the Datanodes this is the storage section ,in case of any read or write operation the jobtracker(master) on the namenode asks the task trackers to do the mapper and the reducers tasks respectively this is the computation part of the Hadoop.

Source:Apache/Hadoop



CONCLUSION

Maximum amount of industry generated data is unstructured. Even if it is structured it is so huge that the traditional RDBMS is a fail for storing Enormous variety ,volume and velocity of the data.Hadoop framework is an asset as it helps in achieving the mail goals of the industry such as the storage, computer and analysis,reliability and fault tolerance, last but not the least the network bandwidth. Thus using Hadoop we can distributed store the data using HDFS and compute it according to the user defined functions in MapReduse.

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References

i. *http://hadoop.apache.org/core/docs/current/hdfs_design.html*

ii. *Pattern-Based Strategy: Getting Value from Big Data. Gartner Group pressrelease. July 2011.*

iii. *.IBM press release. "Using IBM Analytics, Santam Saves $2.4 Million inFraudulent Claims."May 9, 2012. http://www-03.ibm.com/press/us/en/press release/37653.*

iv. *wss.bigdatabigproblems, http://www.greenbiz.com/blog/2013/09/16/big-data-big-problems*

v. *"Big Data for Development: Opportunities & Challenges" - White Paper,http://www.unglobalpulse.org/projects/BigDataforDevelopment*

vi. *Big Data Analytics Advanced Analytics in Oracle Database-An Oracle White Paper.*

vii. *Big Data Adoption –Infrastructure Considerations-A TCS white paper.*

viii. *Architectig A Big Data Platform forAnalytics- An IBM whitepaper.*

ix. *.Architecting A Big Data Platform for Analytics-IBM research report.*

x. *.Teradatas -Big Data Analytics Architecture*, Putting All Your Eggs in Three Baskets.

xi. *Magoulas, Roger, and Ben Lorica Bigdata Technologies and techniques for large scale data," Release 2.0, Number 11, February 2009.*